Although the question tells us about $F_1$ and $F_2$, these are not the only forces acting on the block. We are told that the block, initially, does not slide. Being motionless, it has $a=0$ (the velocity is constant at zero, and constant $v$ means $a=0$). If $a=0$, we know $\sum F_{net}=0$.

(a) Forces in x-direction are balanced, since $a_x=0$. The only forces in this direction are $F_S$ and $F_1$. $F_S=F_1$, then. Changing $F_2$ has no effect on $F_1$ or $F_S$. $F_S$ is unchanged.

(b) In the y-direction, we have three forces:

$$F_{net_y}=0 \Rightarrow N-W-F_2$$

$$N=W+F_2$$

So as $F_2$ increases, so does $N$.

(c) $F_{s,max}=\mu_s N$, so as $N$ increases, $F_{s,max}$ will increase, too.

(d) No, the box will only slide if $F_1$ exceeds $F_{s,max}$. $F_1$ is constant, while $F_{s,max}$ increases, so that will never occur.
(a) The block will slide if its weight exceeds the static friction.

\[ F_{\text{net}} = ma \]

\[ F - N = 0 \rightarrow N = F = 12N \]

\[ F_{\text{max}} = \mu_s N = (0.6)(12N) = 7.2N \]

Looking in y-direction, then, we can find the \( F_s \) which would be needed to hold the block up by setting \( a = 0 \).

\[ F_{\text{net}} = ma \]

\[ F_s - W = 0 \rightarrow F_{\text{needed}} = W = 5N \]

\[ F_{\text{max}} > F_{\text{needed}} \]

Therefore, the block does not slide.

(b) The force on the block from the wall has two parts: the normal force and the friction.

\[ F_s = 5N \hat{j} \text{ and } \vec{N} = -12N \hat{\text{i}} \]

Adding these together, \[ \vec{F}_{\text{net,block}} = (-12N)\hat{i} + (5N)\hat{j} \]
For this block to stay on table we need

\[ F_B \leq N_B \mu_s \]

\[ N_B = m_B g = 711\text{N} \quad \mu_s = 0.25 \]

\[ F = m_g \hat{y} + F_b \hat{x} \]

\[ F \sin 30^\circ = m_g = F_y \]

\[ F \cos 30^\circ = F_b = F_x \]

\[ F_b = N_B \mu_s = F \cos 30^\circ \]

\[ F = \frac{N_B \mu_s}{\cos 30^\circ} = \frac{(711\text{N})(0.25)}{0.866} = 205.25\text{N} \]

\[ F \approx 205\text{N} \]

Also

\[ F \sin 30^\circ = m_g = W_a = 205\text{N} \sin 30^\circ \]

\[ W_a = 103\text{N} \]
The large block rests on a frictionless floor, while there is a friction between the two blocks.

In order for friction to hold up the small block, the contact force between blocks needs to be large enough for \( F_s \) to equal the smaller block’s weight. Here are the free-body diagrams:

- \( \vec{F} \) and \( m \)
- \( \vec{F} \) and \( M \)
- \( N_2 \) and \( W_2 = Mg \)
- \( N_3 \) and \( W_3 = (M+m)g \)

We're looking for the minimum \( F \) which will stick the blocks together, so that means we should set \( F_s = F_{\text{max}} \). Remember, if \( F_s = F_{\text{max}} \), the system is on the verge of slipping. Since we want to apply as little force as possible, the blocks should be just barely stuck. So, then, examining the forces on the small block:

\[
\begin{align*}
\text{x:} & \quad F_{\text{net}} = F - F_{\text{contact}} = m\alpha_x \quad \Rightarrow \quad F = m\alpha_x + F_{\text{contact}} \\
\text{y:} & \quad F_{\text{net}} = F_s - W_1 \\
& \quad = F_{\text{max}} - W_1 \\
& \quad = mg - F_{\text{contact}} - mg = m\alpha_y = 0 \quad \Rightarrow \quad F_{\text{contact}} = \frac{mg}{\mu_s}
\end{align*}
\]

Subbing "\( F_{\text{contact}} \) into the x equation, we find \( F = m\alpha_x + \frac{mg}{\mu_s} \). So, what’s \( \alpha_x \)? We can get it from the third diagram, considering both blocks together:

\[
F_{\text{net}} = F = (M+m)\alpha_x \quad \Rightarrow \quad \alpha_x = \frac{F}{M+m}
\]

So, then,

\[
F = m\left(\frac{F}{M+m}\right) + \frac{mg}{\mu_s} \quad \Rightarrow \quad F = \frac{m}{M+m}F = F(1 - \frac{m}{M+m}) = \frac{mg}{\mu_s}
\]

\[
F = \frac{mg}{\mu_s(1 - \frac{m}{M+m})}
\]
The cylinder is at rest. The tension of the cord is equal to the weight of $M$.

$$ T = W = Mg $$

The centripetal force which keeps $m$ moving in circle is

$$ F_c = m \frac{v^2}{r} $$

On $m$, the only force which can supply the centripetal force is the tension of the cord. Since $M$ is at rest, $m$ is moving in a circle with radius equal to $r$,

$$ F_c = T $$

$$ Mg = T = m \frac{v^2}{r} $$

$$ v^2 = \frac{Mg}{m}r $$

$$ v = \sqrt{\frac{Mg}{m}r} $$
An old streetcar rounds a flat corner of radius 9.1 m at 16 Km/h.

Find: The angle w.r.t. the vertical by the loosely hanging hand straps

\[ v = 16 \text{Km/h} \]

\[ v = \left( \frac{16 \text{Km}}{h} \right) \left( \frac{1000 \text{m}}{\text{Km}} \right) \left( \frac{h}{3600 \text{sec}} \right) = 4.44 \text{m/s} \]

So the free body diagram for the strap

\[ \sum F_y = 0 \]
\[ T \cos \theta - mg = 0 \]
\[ T \cos \theta = mg \]
\[ T = \frac{mg}{\cos \theta} \]

\[ \sum F_x = ma = \frac{mv^2}{r} \]

\[ T \sin \theta = \frac{mv^2}{r} \]

\[ \frac{mg \sin \theta}{\cos \theta} = \frac{yv^2}{r} \]

\[ g \tan \theta = \frac{V^2}{r} \]

\[ \theta = \tan^{-1} \left( \frac{\sqrt{2}}{9.8} \right) \]

\[ \theta = \tan^{-1} \left( \frac{4.44 \text{m/s}}{9.81 \times 9.1} \right) \]

\[ \theta = 12^\circ \]